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Environmental and Economic Benefit Analysis of Proposed Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations

ENVIRONMENTAL AND ECONOMIC BENEFIT ANALYSIS OF THE PROPOSED REVISIONS TO THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REGULATION AND THE EFFLUENT GUIDELINES FOR CONCENTRATED ANIMAL FEEDING OPERATIONS

U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington, DC 20460

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INTRODUCTION AND SUMMARY CHAPTER 1

The U.S. Environmental Protection Agency (EPA) is revising and updating the two primary regulations that ensure that manure, wastewater, and other process waters generated by concentrated animal feeding operations (CAFOs) do not impair water quality. EPA's proposed regulatory changes affect the existing National Pollutant Discharge Elimination System (NPDES) provisions that define and establish permit requirements for CAFOs, and the existing effluent limitations guidelines (ELGs) for feedlots, which establish the technology-based effluent discharge standard that is applied to specified CAFOs. Both of these existing regulations were originally promulgated in the 1970s. EPA is revising the regulations to address changes that have occurred in the animal industry sectors over the last 25 years, to clarify and improve implementation of CAFO requirements, and to improve the environmental protection achieved under these rules.

This report addresses the environmental and economic benefits of several alternative regulatory scenarios, including two scenarios that EPA is proposing. It examines in detail four environmental quality improvements that would result from the regulatory changes: improvements in the suitability of freshwater resources for fishing and swimming; reduced incidence of fish kills; improved commercial shellfishing; and reduced contamination of private wells. Because these are not the only beneficial impacts of the regulatory scenarios considered by EPA — and because, in general, EPA takes a conservative approach to quantifying the benefits analyzed — the Agency believes that this report presents a lower-bound estimate of the beneficial impacts of the proposed scenarios.

This chapter first defines and describes animal feeding operations and CAFOs, then briefly summarizes the environmental problems and industry changes associated with animal feeding operations that EPA is addressing with its proposed regulations. Finally, the chapter outlines the regulatory changes and alternatives that EPA is considering, and provides a summary of the methods and results of the more detailed benefits analyses presented in the remaining chapters.

1.1 DEFINITION OF CAFOS

The term CAFO is a regulatory designation that describes certain animal feeding operations (AFOs). AFOs are defined by federal regulation as lots or facilities where animals "have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12 month period and crops, vegetation forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility" (40 CFR 122.23(b)(1)). AFOs congregate animals on a small land area where feed must be brought to the animals. Winter feeding of animals on pasture or rangeland is not normally considered an AFO.

Current EPA regulations employ a three-tier structure to identify AFOs that are subject to regulation as CAFOs. Tier 1 facilities include any animal feeding operation where more than 1,000 "animal units" (AUs) are confined; such facilities are by definition CAFOs unless discharges from the operation occur only as the result of a 25-year, 24-hour (or more severe) storm event.[1] Tier 2 facilities include AFOs that confine 301 to 1000 AUs; these facilities are defined as CAFOs if:

- Pollutants are discharged into navigable waters through a manmade ditch, flushing system, or other similar man-made device; or
- Pollutants are discharged directly into waters that originate outside of and pass over, across, or through the facility or come into direct contact with the confined animals.

The regulatory definition of a CAFO does not extend to operations with 300 or fewer AUs (i.e., Tier 3 facilities). Under certain circumstances, however (e.g., a facility causing significant surface water impairment), a permitting authority may designate such facilities as CAFOs.

Current CAFO regulations address only those facilities with wet-manure management systems; this eliminates most poultry operations from regulation under the Clean Water Act because they use dry manure management systems. In addition, the current definition of CAFO includes only swine over 55 pounds and mature dairy cattle, assuming that immature swine and heifers would be raised in the same operations as adults. As a result, the regulatory definition does not address the "stand-alone" immature swine or heifer operations that have proliferated in the last two decades.

USDA reports that there were 1.2 million livestock and poultry operations in the United States in 1997. This number includes all operations that raise beef or dairy cattle, hogs, chickens (broilers or layers), and turkeys, and includes both confinement and non-confinement (i.e., grazing

[1] Animal units are defined in EPA's current regulations at 40 CFR 122 and vary by animal type. An AU is considered equivalent to one beef cow.

and rangefed) production.[2] Of these, EPA estimates that there are about 376,000 AFOs that raise or house animals in confinement, as defined by the existing regulations. For many of the animal sectors, it is not possible to estimate from available data what proportion of the total livestock operations have feedlots (i.e., confinement) and what proportion are grazing operations only. For analytical purposes, EPA has therefore assumed that all dairy, hog, and poultry operations are AFOs. Exhibit 1-1 summarizes the estimated total number of AFOs of all sizes in each of the four major livestock categories, based on 1997 data. EPA estimates that only a subset of these AFOs will be regulated as CAFOs.

Exhibit 1-1

NUMBER OF ANIMAL FEEDING OPERATIONS
(based on 1997 data)

Sector	Total AFOs
Beef operations, including both cattle and veal operations.	106,930
Dairy operations, including both milk and heifer operations.	118,130
Hog operations, including both "farrow to finish" and "grower to finish" operations.	117,860
Poultry operations, including broilers, layers (both wet and dry operations) and turkeys.	123,750
Sum Total	466,670
Total AFOs[1]	**375,740**

Source: EPA estimates derived from published USDA/NASS data, including 1997 Census of Agriculture. For more information, see *Technical Development Document of Proposed Effluent Limitations Guidelines for Animal Feeding Operations*.

[1] "Total AFOs" eliminates double counting of operations with mixed animal types. Based on survey level Census data, operations with mixed animal types account for roughly 20 percent of total AFOs.

1.2 CURRENT ISSUES RELATED TO CAFOS

AFOs (including CAFOs) produce and manage large amounts of animal waste, most in the form of manure. USDA estimates that 291 billion pounds (132 million metric tons) of "as excreted" manure were generated in 1997 from major livestock and poultry operations. Despite the existing ELG and NPDES regulations that define CAFOs and regulate their discharges, the management of animal wastes at AFOs has continued to be associated with environmental problems, including large spills of manure, fish kills, and outbreaks of *Pfiesteria*. In addition, industry changes in recent years may contribute to and exacerbate the problems caused by releases of manure from AFOs. EPA is revising the existing regulations with the following goals:

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[2] EPA's proposed regulatory changes do not address certain types of animal confinement operations, such as farms that raise sheep, lambs, goats, horses, and other miscellaneous animal species, as well as nontraditional animals, such as bison and various exotic species.

- To address reports of continued discharge and runoff of manure and nutrients from livestock and poultry farms;
- To update the existing regulations to reflect structural changes in these industries over the last few decades; and
- To improve the effectiveness of the CAFO regulation.

Below we summarize the potential environmental impacts of manure releases from AFOs, and outline the recent industry changes that may exacerbate these impacts.

1.2.1 Potential Environmental Impacts of CAFOs

Manure management practices at AFOs can include storage in piles or in open waste lagoons, followed by land application to agricultural fields as fertilizer. While some discharges from regulated CAFOs are governed as point sources, unregulated releases of manure from waste piles or lagoons and overapplication of manure to agricultural lands can affect nearby surface and groundwater. National and local studies have confirmed the presence of manure pollutants in surface waters. Once contaminants from manure have reached surface waters they can cause a variety of ecological and human health problems, including water quality impairments, ecological impacts, and human health effects from recreational exposure or from contaminated drinking water.

1.2.1.1 Water Quality Impairments

EPA's 1998 *National Water Quality Inventory*, prepared under Section 305(b) of the Clean Water Act, identifies agriculture (including irrigated and non-irrigated crop production, rangeland, feedlots, pastureland, and animal holding areas) as the leading contributor to identified water quality impairments in the nation's rivers and lakes, and the fifth leading contributor to identified water quality impairments in the nation's estuaries. The report also identifies the key pollutants and stressors that impair the nation's waters. Among the most problematic pollutants are several - including pathogens, nutrients, and oxygen depleting substances - that are associated commonly, although not exclusively, with animal waste.[3]

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[3] The *National Water Quality Inventory 1998 Report to Congress* notes that 28 states and tribes reported impairment by agricultural subcategory. Specifically, these states and tribes reported that animal feeding operations degraded 16 percent of impaired river miles; range and pasture grazing degraded 11 and 6 percent of impaired river miles, respectively; and irrigated and non-irrigated crop production degraded 18 and 27 percent of impaired river miles, respectively.

1.2.1.2 Ecological Impacts

The most dramatic ecological impacts associated with manure pollutants in surface waters are massive fish kills. Incomplete records indicate that every year dozens of fish kills associated with AFOs result in the deaths of hundreds of thousands of fish. In addition, manure pollutants such as nutrients and suspended solids can seriously disrupt aquatic systems by over-enriching water (in the case of nutrients) or by increasing turbidity (in the case of solids). Excess nutrients cause fast-growing algae blooms that reduce the penetration of sunlight in the water column, and reduce the amount of available oxygen in the water, reducing fish and shellfish habitat and affecting fish and invertebrates. Manure pollutants can also encourage the growth of toxic organisms, including *Pfiesteria*, which has also been associated with fish kills and fish disease events. Reduction in biodiversity due to animal feeding operations has also been documented; for example, a study of three Indiana stream systems found fewer fish and more limited diversity of fish species downstream of CAFOs than were found downstream of study reference sites.

1.2.1.3 Human Health Effects

Manure contains over 100 human pathogens; contact with some of these pathogens during recreational activities in surface water can result in infections of the skin, eye, ear, nose, and throat. Eutrophication due to excess nutrients can also promote blooms of a variety of organisms that are toxic to humans either through ingestion or contact. This includes the estuarine dinoflagellate *Pfiesteria piscicida*. While *Pfiesteria* is primarily associated with fish kills and fish disease events, the organism has also been linked with human health impacts through dermal exposure. Finally, even with no visible signs of algae blooms, shellfish such as oysters, clams and mussels can carry toxins produced by some types of algae in their tissue. These can affect people who eat contaminated shellfish.

Contaminants from manure, including nitrogen, algae, and pathogens, can also affect human health through drinking water sources and can result in increased drinking water treatment costs. For example, nitrogen in manure can be transported to drinking water as nitrates, which are associated with human health risks. EPA has identified nitrate as the most widespread agricultural contaminant in drinking water wells. Algae blooms triggered by nutrient pollution can affect drinking water by clogging treatment plant intakes, producing objectionable tastes and odors, and reacting with the chlorine used to disinfect drinking water to produce harmful chlorinated byproducts (e.g., trihalomethanes).

1.2.2 Recent Industry Trends

Since EPA promulgated the existing ELG and NPDES regulations governing CAFOs in the 1970s, a number of trends in the livestock and poultry industries have influenced the nature of pollution from AFOs and the potential for contamination of surface and groundwater. These trends

include a combination of industry growth and concentration of animals on fewer, larger farms; location of farms closer to population centers; and advances in farm production practices and waste management techniques. The changes in the industry have limited the effectiveness of the current regulations that define and govern releases from CAFOs.

1.2.2.1 Increased Production and Industry Concentration

U.S. livestock and poultry production has risen sharply since the 1970s, resulting in an increase in the amount of manure and wastewater generated annually. The Census of Agriculture reports 1997 turkey sales of 299 million birds, compared to 141 million sold in 1978. Sales of broilers increased to 6.4 billion in 1997 from 2.5 billion in 1974.[4] Red meat production also rose during the 1974-1997 period; the number of hogs and pigs sold in 1997 totaled 142.6 million, compared to 79.9 million in 1974.

As production has increased, the U.S. livestock and poultry sectors have also consolidated animal production into a smaller number of larger-scale, highly specialized operations that concentrate more animals (and manure) in a single location. At the same time, significant gains in production efficiency have increased per-animal yields and the rate of turnover of animals between farm and market. These large AFOs can present considerable environmental risks, because they often do not have an adequate land base for manure disposal through land application. As a result, large facilities must incur the risks associated with storing significant volumes of manure, or must attempt to maximize the application of manure to the limited land they have available. By comparison, smaller AFOs manage fewer animals and tend to concentrate less manure nutrients at a single location. These operations are more likely to have sufficient cropland and fertilizer needs to land apply manure nutrients generated at a livestock or poultry business.

1.2.2.2 Location of Animal Operations Closer to Consumer Markets

Since the 1970s, the combined forces of population growth and re-location of operations closer to consumer markets and processing sectors have resulted in more AFOs located near densely populated areas. Surface waters in these areas face additional stresses from urban runoff and other point sources. The proximity of large AFOs to human populations thus increases the potential for human health impacts and ecological damage if manure and wastewater at AFOs is improperly discharged.

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[4] This more than two-fold increase in the number of broilers raised annually signals the need to review the existing CAFO regulations, which effectively do not cover broiler operations since virtually no such operations use wet manure management systems.

1.2.2.3 Advances in Agriculture Production Practices to Manage and Dispose Manure

Continued research by USDA, state agencies and universities has led to advances in technologies and management practices that minimize the potential environmental degradation attributable to discharge and runoff of manure and wastewater. Today, there are many more practicable options to properly collect, store, treat, transport, and utilize manure and wastewater than there were in the 1970s, when the existing regulations were instituted. As a result, current regulations do not reflect the full range of management practices and technologies that may be implemented to achieve greater protection of the environment (e.g., by more effectively treating certain constituents present in animal manure or by converting manure into a more marketable form). In addition, during the time since promulgation of the existing regulation, certain practices have proven to be relatively less protective of the environment. There is documented evidence that lagoons may leak if not properly maintained, and evidence of overapplication of manure and nutrient saturation of soils in some parts of the country.

1.3 PROPOSED CHANGES TO CAFO REGULATIONS

In response to persistent reports of environmental problems, and to changes in the industries and technologies associated with AFOs, EPA is proposing changes to both the NPDES regulations for CAFOs and the ELG regulations for feedlots. Proposed changes to the NPDES regulations for CAFOs affect which animal feeding operations are defined as CAFOs and are therefore subject to the NPDES permit program. Changes to the ELG regulations for feedlots affect which technology-based requirements will apply to CAFOs.

EPA's analysis of the benefits of revised regulations considers four alternatives for the NPDES definition of a CAFO (described as Scenarios 1, 2/3, 4a, and 4b), combined with two alternative ELG regulations (Options 1 and 2), yielding a total of eight regulatory scenarios. EPA is co-proposing two of these scenarios. The first incorporates NPDES scenario 2/3 and ELG Option 2; this scenario would preserve the current three-tier structure for identifying facilities that are CAFOs (though with revised conditions for identifying CAFOs within the tiers), and would revise the ELG to establish a phosphorus-based manure application limit. The second proposed scenario incorporates NPDES scenario 4a and ELG Option 2; this scenario would replace the current three-tier structure with a two-tier structure, and would also incorporate a phosphorus-based ELG. Specific proposed changes are described in more detail below, and are summarized in Exhibit 1-2.

1.3.1 <u>Changes to NPDES Regulations</u>

EPA considered four regulatory scenarios that reflect changes to the current approach to determining which facilities are CAFOs that are subject to NPDES requirements. Scenario 1 would retain the existing three-tier structure for identifying CAFOs (described in section 1.1). Scenario 2/3 would also retain the current three-tier structure, but would revise the conditions within the tiers for determining which facilities are CAFOs. Scenario 4a would replace the current three-tier structure

with a two-tier structure that would alter the definition of a CAFO to include all AFOs with 500 or more AUs; operations with fewer than 500 AUs would be regulated at the discretion of the permitting authority (similar to the current Tier 3 facilities). Finally, Scenario 4b would change to a two-tier structure similar to that in Scenario 4a, but would define as a CAFO any operation with 300 or more animal units.[5]

As noted above, EPA has chosen to co-propose NPDES Scenario 2/3 and NPDES Scenario 4a. In doing so, the Agency is soliciting comments on regulatory approaches that, on a national basis, yield similar environmental benefits, but offer different administrative benefits and have differing impacts on regulated industry sectors. Specifically:

- Scenario 2/3 would apply a three-tier structure combined with a risk-based approach to identify which AFOs pose a potential to discharge. This scenario would automatically define all operations over 1,000 AUs as CAFOs. AFOs with between 300 and 1,000 AUs would be required to *either* apply for an NPDES permit *or* certify to the permitting authority that they do not meet any of the conditions that define a CAFO. An advantage of this approach is that it would offer states flexibility in developing requirements and programs that could reduce the number of facilities needing NPDES permits. A potential disadvantage, however, is the complexity associated with administering this approach, as well as the cost associated with extending the certification/application requirement to facilities as small as 300 AUs.

- In contrast to Scenario 2/3, the two-tier structure of Scenario 4a would define all operations with at least 500 AUs as CAFOs. As such, all facilities with at least 500 AUs would be required to obtain and comply with an NPDES permit; operations with fewer than 500 AUs would be subject to permitting only if designated by the permitting authority as a significant contributor of pollution. An advantage of this approach is that it simplifies the structure of the regulations and supports EPA's goal of clarifying their scope. In addition, operations with at least 300 but fewer than 500 AUs would not automatically incur permitting or certification costs; however, the potential benefits associated with a more flexible, risk-based approach to permitting operations with between 500 and 1,000 AUs would be foregone.

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[5] Each of the regulatory scenarios analyzed also reflects several proposed structural changes that would revise the CAFO definition and permit requirements under the NPDES permit program. For example, EPA is proposing to include dry poultry and stand-alone immature swine and heifer operations as AFOs; this change would increase the number of facilities that meet the definition of a CAFO and must obtain an NPDES permit. In addition, EPA is proposing several clarifications designed to assure that all facilities meeting the CAFO definition obtain an NPDES permit. Similarly, EPA is proposing changes to the ELGs for feedlots that would clarify the development of technical standards for manure storage and land application operations. These changes from the current baseline are reflected in all of the regulatory scenarios.

EPA's proposed regulatory scenarios both reflect the phosphorus standard. Because manure is phosphorus rich, nitrogen-based manure application is likely to result in application of phosphorus in excess of crop requirements. Although excess phosphorus does not usually harm crops and is often adsorbed by soils, the capacity of soil to adsorb phosphorus will vary by soil type. Recent observations indicate that soils can and do become saturated with phosphorus. When saturation occurs, continued application of phosphorus in excess of what can be used by the crop and soil will result in phosphorus leaving the field with storm water via leaching or runoff; eutrophication of surface waters can result.

1.3.3 Number of Regulated Operations

EPA has estimated the likely number of AFOs that would be regulated under the revised definition of CAFO in each of the four NPDES scenarios (i.e., Scenarios 1, 2/3, 4a, and 4b). EPA analyzed data from the USDA's 1997 Census of Agriculture to identify AFOs and CAFOs. EPA first determined the number of operations that raise animals under confinement by using available data on the total number of livestock and poultry facilities. Next, EPA determined the number of CAFOs based on the number of facilities that discharge or have the potential to discharge to U.S. waters and which meet a minimum size threshold (i.e., number of animals) as defined by the regulatory options. Exhibit 1-3 shows the number of CAFOs estimated for each scenario.

1.4 ANALYTIC METHODS AND RESULTS

To determine the economic benefits of the regulatory scenarios, EPA performed four separate analyses of expected changes in environmental quality that would likely result from reduced AFO pollution. These include:

- **Improvements in Water Quality and Suitability for Recreational Activities:** this analysis estimates the economic value of improvements in inland surface water quality that would increase opportunities for recreational fishing and swimming;

- **Reduced Incidence of Fish Kills:** this analysis estimates the economic value of a potential reduction in the number of fish kills caused by AFO-related waste;

- **Improved Commercial Shellfishing:** this analysis characterizes the impact of pollution from AFOs on access to commercial shellfish growing waters, and values the potential increase in commercial shellfish harvests that may result from improved control of that pollution; and

Exhibit 1-3

ESTIMATED NUMBER OF CAFOS UNDER ALTERNATIVE REGULATORY SCENARIOS*

Production Sector	Currently Regulated	NPDES Scenario 1	NPDES Scenario 2/3	NPDES Scenario 4a	NPDES Scenario 4b
Beef	2,220	2,290	2,720	3,080	4,080
Dairy	3,150	3,560	5,430	3,760	7,140
Heifers	620	590	830	800	1,050
Veal	20	20	70	90	210
Swine	5,260	5,630	7,520	8,550	14,370
Layers	470	870	1,420	1,640	2,050
Broilers	620	4,320	13,830	9,780	14,140
Turkeys	50	420	1,680	1,280	2,100
Total	**12,410**	**17,700**	**33,500**	**28,980**	**45,140**

* AFOs with more than one animal type are counted more than once; numbers have been rounded to nearest ten.

- **Reduced Contamination of Private Wells:** this analysis examines the impact of the revised regulations on groundwater quality, and values predicted improvements in the quality of aquifers that supply private wells.

Exhibit 1-4 summarizes the results of these four studies for each of the regulatory scenarios. It is important to note that these results are not intended to represent the total value of all benefits associated with a reduction in AFO pollutants; they include only the subset of benefits that is addressed by EPA's analyses. Moreover, EPA's analyses generally take a conservative approach to quantifying benefits; therefore, the results are likely to reflect conservative estimates of the specific benefits that EPA has examined.

1.5 ORGANIZATION OF REPORT

The remainder of this report presents EPA's analysis of the benefits expected under each of the regulatory scenarios considered. Specifically:

- Chapter 2 provides a detailed description of the potential impacts of AFOs on environmental quality and human health;

Exhibit 1-4

ESTIMATED ANNUALIZED BENEFITS OF CHANGES IN REGULATION OF CAFOS
(1999 dollars, millions)

Regulatory Scenario	Recreational and Non-use Benefits	Reduced Fish Kills	Improved Shellfishing	Reduced Private Well Pollution	Total
Option 1- Scenario 1	$4.9	$0.1 - $0.2	$0.1 - $1.8	$33.3 - $49.0	$38.4 - $55.9
Option 1- Scenario 2/3	$6.3	$0.1 - $0.3	$0.2 - $2.4	$33.3 - $49.1	$39.9 - $58.0
Option 1- Scenario 4a	$5.5	$0.1 - $0.3	$0.2 - $2.2	$35.5 - $52.2	$41.2 - $60.2
Option 1- Scenario 4b	$7.2	$0.1 - $0.3	$0.2 - $2.6	$35.5 - $52.2	$43.0 - $62.3
Option 2- Scenario 1	$87.6	$0.2 - $0.3	$0.2 - $2.1	$35.4 - $52.1	$123.3 - $142.1
Option 2- Scenario 2/3*	$127.1	$0.2 - $0.4	$0.2 - $2.7	$35.4 - $52.1	$163.0 - $182.3
Option 2- Scenario 4a*	$108.5	$0.2 - $0.4	$0.2 - $2.4	$36.6 - $53.9	$145.5 - $165.1
Option 2- Scenario 4b	$145.0	$0.2 - $0.4	$0.2 - $3.0	$36.6 - $53.9	$182.1 - $202.2

* Proposed scenarios.

- Chapter 3 describes the range of benefits that would result from decreased AFO loadings, and outlines EPA's general approach to quantifying and valuing the subset of benefits analyzed;

- Chapter 4 assesses the value of changes in surface water quality that would result from a reduction in AFO loadings, focusing on changes in the quality of freshwater resources that would improve their suitability for fishing and swimming;

- Chapter 5 assesses the value of reducing the incidence of fish kills attributable to pollution from AFOs;

- Chapter 6 assesses the value of improved commercial shellfishing resulting from decreased AFO loadings;

- Chapter 7 assesses the value of reduced contamination of private wells associated with reductions in the pollution of groundwater by AFOs; and

- Chapter 8 provides the summary and conclusions of the benefits analysis.